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First-Named Inventor or Application Identifier	Simmons et al.		
Title:	DUAL MODE POWER MANAGEMENT SYSTEM		
Express Mail Label No.:	JC564 U.S. PRO 09/544228 04/07/00		

(Only for new nonprovisional applications under 37 CFR 1.53(b))

<b>APPLICATION ELEMENTS</b> (see MPEP chapter 600 concerning utility patent application contents)	<b>ADDRESS TO:</b>	Assistant Commissioner for Patents Box Patent Application Washington, D.C. 20231
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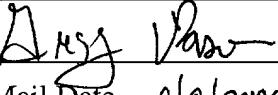
1. <input checked="" type="checkbox"/> Fee Transmittal Form <i>in duplicate</i>			
2. <input checked="" type="checkbox"/> Specification	Total Pages	12	
3. <input checked="" type="checkbox"/> Drawings	Total Sheets:	3	
4. <input checked="" type="checkbox"/> Oath or Declaration with Power of Attorney	Total Pages	3	
a. <input checked="" type="checkbox"/> Newly Executed (original or copy)			
b. <input type="checkbox"/> Copy from prior application (37 CFR §1.63(d)) (for continuation/divisional with Box 17 completed)			
i. <input type="checkbox"/> <u>Deletion of Inventor(s):</u> Signed statement attached deleting inventor(s) named in the prior application (see 37 CFR §1.63(d)(2) and 1.33(b))			
5. <input type="checkbox"/> Incorporation by Reference ( <i>useable if Box 4b is checked</i> ) The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.			
6. <input type="checkbox"/> Microfiche Computer Program (Appendix)			
7. <input type="checkbox"/> Nucleotide and/or Amino Acid Sequence Submission			

## ACCOMPANYING APPLICATION PARTS

8. <input checked="" type="checkbox"/> Assignment Papers ( <i>cover sheet and document(s)</i> )			
9. <input type="checkbox"/> 37 CFR §3.73(b) Statement	<input type="checkbox"/> Power of Attorney		
(when there is an assignee)			
10. <input type="checkbox"/> English Translation Document ( <i>if applicable</i> )			
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(IDS)/PTO-1449			
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17.	<b>IF A CONTINUING APPLICATION</b> <i>check appropriate box and supply the requisite information below and in a preliminary amendment:</i>			
	<input type="checkbox"/>	Continuation	<input type="checkbox"/>	Divisional
	<input type="checkbox"/>	Continuation- in- Part (CIP)	Prior Appl. No. _____	
Prior Appl. information:   Examiner:		Group/Art Unit:		

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APPLICATION INFORMATION

Title Line One:: DUAL MODE POWER MANAGEMENT SYSTEM  
Total Drawing Sheets:: 3  
Formal Drawings?:: Yes  
Application Type:: Utility  
Docket Number:: PT03130U  
Secrecy Order in Parent Appl.?:: No

Source:: PrintEFS Version 1.0.1

## DUAL MODE POWER MANAGEMENT SYSTEM

## Field of the Invention

5 This invention relates in general to power generation and regulation circuits and more particularly to an improved low voltage, low power generation and regulation circuit.

## Background of the Invention

10

In portable battery operated products such as a wireless selective call capable device, many attempts have been made to design circuits that effectively control and distribute power to functional circuits within the device.

15 Prior art systems have used both capacitive and inductive topology voltage multipliers for generating voltages necessary to power such devices as microcomputers, information displays, linear support circuits for power distribution and management, as well as signal processors.

20 However, a persistent problem has been that the efficiency of such voltage multipliers is typically low, thus resulting in an unnecessary loss of power when used to supply said devices.

Thus, what is needed is an efficient apparatus that not 25 only generates the necessary voltage supplies, but also intelligently selects the most efficient voltage supply available for powering such devices.

## Brief Description of the Drawings

30

FIG. 1 is a block diagram of a selective call receiver in accordance with the preferred embodiment of the present invention.

35 FIG. 2 is a block diagram of an intelligent power source selection circuit in accordance with the preferred embodiment of the present invention.

FIG. 3 is a schematic diagram of a switching circuit associated with the intelligent power source selection circuit illustrated in FIG. 2.

FIG. 4 is a flow diagram illustrating operation of the intelligent power source selection circuit shown in FIG. 2, in accordance with the preferred embodiment of the present invention.

5 FIG. 5 is a graphical illustration of operating regions associated with the intelligent power source selection circuit shown in FIG. 2, in accordance with the preferred embodiment of the present invention.

10

### Description of a Preferred Embodiment

Referring to FIG. 1, a battery **100** powered selective call receiver comprises an antenna **110** coupled to a receiver **108**. The receiver **108** is coupled to a main control board **114** which may strobe the receiver on and off for power saving purposes. Furthermore, the receiver **108** couples received information to the main control board **114** where it is routed to the demodulator for processing and recovery of modulated information that may be presented to a user in any number of formats such as audio, text, video, etc.

A support circuit **104** may, and in this case does supply a multiplied voltage  $V_{dd}$  **106** to a microcontroller **112** as well as a power management circuit **126** known interchangeably hereafter as an intelligent power source selection circuit **126**. The power management circuit **126** has inputs of a battery voltage  $V_{bat}$  **102** and the multiplied voltage from the support circuit. In the preferred embodiment of the present invention, the power management circuit **126** distributes power to at least the demodulator **122**, a decoder **124**, and oscillator **118**, a PLL (Phase Locked Loop) **120**, and an SPI (Serial Peripheral Interface) **116**. Alternatively, the power management circuit **126** would also supply power to the microcontroller **112**. These devices are arranged such that the selective call receiver can operate to receive radio frequency signals and recover information contained therein for presentation to the user in any number of formats as detailed above.

Referring to FIG. 2, the illustration shows a block diagram of the intelligent power source selection circuit

126 in accordance with the preferred embodiment of the present invention.

The intelligent power source selection circuit 126 operates using the battery 100, a microcontroller programmed (or fixed) voltage reference 200, and the multiplied voltage  $V_{dd}$  106. The primary purpose of the intelligent power source selection circuit 126 is to select the most efficient power source and supply that selected source to circuits associated with the portable communication or other portable device. By doing this, the time between either battery replacement or charging is significantly extended, thus making the device using this intelligent power source selection circuit 126 more desirable to a portable device user. Marketing studies have determined that a majority of portable device users will select a device that has a longer battery life over one with a shorter battery life. Therefore, devices using the present invention, considering that all other operational aspects of similar devices remain equal, will be selected by users over devices not having the present invention.

Operationally, the battery 100 is coupled to an input 102 of an output selector 204 as well as to an input of a comparator 202 having a predetermined hysteresis characteristic 202. Further, the multiplied voltage  $V_{dd}$  106 is coupled to the output selector 204. The microcontroller programmed (or fixed) voltage reference 200 is coupled to both the comparator 202 and a voltage following operational amplifier 206 that generates an output reference voltage  $V_{ref}$ , 210 which substantially follows a reference voltage  $V_{ref}$  208. The output voltage  $V_{ref}$ , 210 is then coupled to the output selector 204. Based on the flow diagram shown in FIG. 4, and in response to a magnitude of the battery voltage  $V_{bat}$  102 and the reference voltage  $V_{ref}$  208, the comparator 202 operates to couple a selection signal to the output selector 204 which in turn selects the most efficient voltage supply from the multiplied voltage  $V_{dd}$  106 and the battery voltage  $V_{bat}$  102 as  $V_{out}$  212. Selection as described here always insures that the minimum amount of power is drawn from the inefficient multiplied voltage supply over time. Thus, the battery or other primary power source will

last longer since the amount of power lost to inefficient multiplier conversions is always minimized.

Referring to FIG. 3, a schematic diagram illustrates the internals of the output selector **204** which comprises a switching circuit associated with the intelligent power source selection circuit **126**.

First, the output reference voltage  $V_{ref}$  **210** is coupled to the inputs of two parallel transmission gates **302**, **304**. These transmission gates are controlled by the comparator's **202** selection signal such that when the signal is in a first state (low), transmission gate **302** is activated which couples the output reference voltage  $V_{ref}$  **210** to switch **306**, coupling the battery voltage  $V_{bat}$  **102** as a supply for  $V_{out}$  **212** which supplies a regulated voltage to circuitry within the portable device. When the comparator's **202** selection signal is in a second state (high), transmission gate **304** is activated which couples the output reference voltage  $V_{ref}$  **210** to switch **308**, coupling the multiplied voltage  $V_{dd}$  **106** as a supply for  $V_{out}$  **212** which supplies a regulated voltage to circuitry within the portable device. To prevent the generation of noise or glitches on the selected power output, the comparator has a predetermined amount of hysteresis such that the battery voltage  $V_{bat}$  **102** must traverse a hysteresis window before selection of the less efficient power supply occurs. Similarly, when and if the battery voltage  $V_{bat}$  **102** recovers from a drop caused by events such as a high current demand by the portable device's circuitry, the battery voltage must again traverse the hysteresis window before selection of the more efficient power supply occurs. In this manner, the circuitry powered by this invention is subjected to minimal interference due to power supply switching transients.

Referring to FIG. 4, a flow diagram illustrates operation of the intelligent power source selection circuit **126** in accordance with the preferred embodiment of the present invention.

At power up **402**, the circuit tests **404** to see if the battery voltage  $V_{bat}$  **102** is greater than the output reference voltage  $V_{ref}$  **210** plus the predetermined hysteresis. If this is true, the output is selected **406** to source the battery

voltage  $V_{bat}$  102 as  $V_{out}$  212. If this test fails, the output is selected 408 to source the multiplied voltage  $V_{dd}$  106 as  $V_{out}$  212. Once  $V_{out}$  212 is selected as the multiplied voltage  $V_{dd}$  106, the battery voltage  $V_{bat}$  102 is tested 410 until it's 5 magnitude is greater than a sum of the output reference voltage  $V_{ref}$  210 and the predetermined hysteresis. When that condition is true, the output is selected 406 to source the battery voltage  $V_{bat}$  102 as  $V_{out}$  212. However, if the test fails, the intelligent power source selection circuit 126 10 will continue to source  $V_{out}$  212 as the multiplied voltage  $V_{dd}$  106. 15

Referring to FIG. 5, a graphical illustration shows the regions associated with operation of the intelligent power source selection circuit 126 in accordance with the 15 preferred embodiment of the present invention.

Region 1 500 as shown in FIG. 5 is typically known as a startup region. In this region 500, power has just been activated to the circuitry associated with the portable device. Curve 502 shows the battery or primary power source 20 voltage  $V_{bat}$  102 which rises rapidly to a point above a regulated voltage  $V_{out}$  212 shown as curve 504. Since the multiplied voltage  $V_{dd}$  106 shown as curve 506 is well below the regulated voltage  $V_{out}$  212 shown as curve 504 in this region, only one choice for the regulated voltage  $V_{out}$  212 25 supply is possible and it is the battery voltage  $V_{bat}$  102.

In region 2 508, the battery voltage  $V_{bat}$  102 remains above the regulated voltage  $V_{out}$  212 and thus, power for regulated voltage  $V_{out}$  212 is still derived from the battery voltage  $V_{bat}$  102. Not until the point shown as 512 does the battery 30 voltage  $V_{bat}$  102 fall below the predetermined hysteresis limit of the comparator 202, at which time the intelligent power source selection circuit 126 operates to select the multiplied voltage  $V_{dd}$  106 as a supply for  $V_{out}$  212. In region 3 510, the battery voltage  $V_{bat}$  102 remains below the 35 regulated voltage  $V_{out}$  212 and not until the battery voltage  $V_{bat}$  102 reaches above the point where it exceeds the sum of the regulated voltage  $V_{out}$  212 and the predetermined hysteresis limit of the comparator 202, does the intelligent power source selection circuit 126 operate again to select

the battery voltage  $V_{bat}$  **102** as a supply for the regulated voltage  $V_{out}$  **212**.

As one of ordinary skill in the art would appreciate, the implementation described here is but one way to realize the claimed invention. More particularly, any semiconductor technology, e.g., CMOS, bipolar, etc., may be used to fabricate elements such as the transmission gates **302**, **304**, power switches **306**, **308**, amplifier **206**, comparator **202**, or associated components such as the receiver **108**, demodulator **122**, support circuit **104**, decoder **124**, and microcontroller **112**. Moreover, it is contemplated that the present invention be used in conjunction with portable electronic devices such as pagers, advanced messaging devices (1-way and 2-way), smart cards, cellular and other portable telephones, personal digital assistants, and all forms of portable computing devices. Any device that requires a stable regulated voltage supply will benefit from the use of the present invention because the useful operating life of a portable device will be extended between either battery replacements or charges.

What is claimed is:

## CLAIMS

1. A power management system comprising:
  - a primary power source;
  - 5 a secondary power source generated from the primary power source; and
  - a power output selector coupled to the primary power source and the secondary power source, the power output selector operating to select:
    - 10 (a) the primary power source as a power supply at a desired regulated power output, during initialization of the power management system and at any other time during operation of the power management system that a magnitude of the primary power source exceeds a magnitude of the
    - 15 secondary power source,
    - (b) the primary power source as the power supply at the desired regulated power output, at any time after initialization of the power management system that the magnitude of the primary power source exceeds the magnitude
  - 20 (c) the secondary power source as the power supply at the desired regulated power output, at any time after initialization of the power management system that the magnitude of the secondary power source exceeds the magnitude of the primary power source and the magnitude of the primary power source is less than the desired regulated power output.
2. The power management system according to claim 1  
30 wherein the primary power source is a battery.
3. The power management system according to claim 2  
wherein the power supply is maintained at a nominal voltage produced by the battery.
- 35 4. The power management system according to claim 3  
wherein the nominal voltage produced by the battery is approximately one volt DC.

5. The power management system according to claim 1 wherein the power supply is maintained at a voltage of substantially one volt DC.

5 6. The power management system according to claim 1 wherein the secondary power source has a typical operating voltage magnitude that is greater than the primary power source.

10 7. The power management system according to claim 1 wherein the desired regulated power output has a typical operating voltage magnitude of substantially one volt DC.

8. The power management system according to claim 1  
15 further comprising:

20 a comparator coupled to the primary power source, a reference voltage, and the power output selector, the comparator having a pair of switching thresholds defined as a difference and a sum of the reference voltage and a predetermined hysteresis voltage, respectively.

9. The power management system according to claim 8 wherein the comparator controls selection of the primary power source for power output in response to a primary power source voltage being greater than the difference between the reference voltage and the predetermined hysteresis voltage.  
25

10. The power management system according to claim 8 wherein the comparator controls selection of the secondary power source for power output in response to a primary power source voltage being less than the difference between the reference voltage and the predetermined hysteresis voltage.  
30

11. The power management system according to claim 8  
wherein the comparator controls selection of the primary  
power source for power output in response to a primary power  
source voltage being greater than the sum of the reference  
5 voltage and the predetermined hysteresis voltage.

12. The power management system according to claim 8  
further wherein the comparator controls selection of the  
secondary power source for power output in response to a  
10 primary power source voltage less than the sum of the  
reference voltage and the predetermined hysteresis voltage.

13. The power management system according to claim 8  
wherein the power output selector comprises:  
15

a first switch coupled to the comparator and having  
an input coupled to the primary power source; and  
a second switch coupled to the comparator and having  
an input coupled to the secondary power source;  
wherein the first switch and the second switch are  
20 activated in a mutually exclusive manner to provide for  
power output at a common output.

14. A power management system comprising:

- a primary power source;
- a secondary power source generated from the primary power source;

5        a comparator coupled to the primary power source, a reference voltage, and the power output selector, the comparator having a switching threshold defined as a difference of the reference voltage and a predetermined hysteresis voltage; and

10      a power output selector coupled to comparator, the primary power source and the secondary power source, the power output selector operating to select:

- (a) the primary power source as a power supply at a desired regulated power output, during initialization of the power management system and at any other time during operation of the power management system that a magnitude of the primary power source exceeds a magnitude of the secondary power source by a magnitude determined as a difference between the reference voltage and the predetermined hysteresis voltage,
- (b) the primary power source as the power supply at the desired regulated power output, at any time after initialization of the power management system that the magnitude of the primary power source exceeds the magnitude of a desired regulated power output by the magnitude determined as the difference between the reference voltage and the predetermined hysteresis voltage, and
- (c) the secondary power source as the power supply at the desired regulated power output, at any time after initialization of the power management system that the magnitude of the secondary power source exceeds the magnitude of the primary power source by the predetermined hysteresis voltage and the magnitude of the primary power source is less than the desired regulated power output.

35

15. The power management system according to claim 14 wherein the primary power source is a battery.

16. The power management system according to claim 14 wherein the secondary power source has a typical operating voltage magnitude that is greater than the primary power source.

5

17. The power management system according to claim 14 wherein the power output selector comprises:

a first switch coupled to the comparator and having an input coupled to the primary power source; and

10 a second switch coupled to the comparator and having an input coupled to the secondary power source;

wherein the first switch and the second switch are activated in a mutually exclusive manner to provide for power output at a common output.

## DUAL MODE POWER MANAGEMENT SYSTEM

**Abstract of the Disclosure**

5        A power management system has a primary power source (100) and a secondary power source (106) generated from the primary power source (100) with a power output selector (204) coupled to each for selecting power for a regulated power output (212). First, during initialization and at any  
10      other time during operation, when the primary power source (102) exceeds the secondary power source (106), the primary power source (102) is used as a power supply for the regulated power output (212). Second, at any time after initialization that the primary power source (102) exceeds  
15      the regulated power output (212), the primary power source (102) is used as the power supply for the regulated power output (212). Third, at any time after initialization that the secondary power source (106) exceeds the primary power source (106) and the primary power source (102) is less than  
20      the regulated power output (212), the secondary power source (106) is used as the power supply for the regulated power output (212).

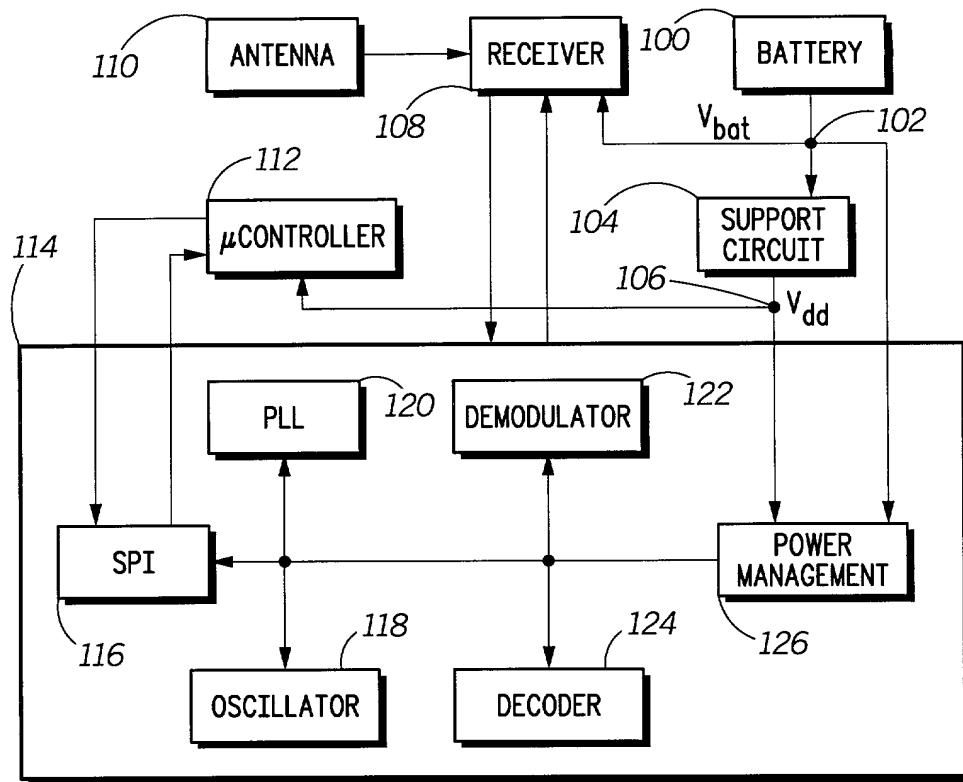


FIG. 1

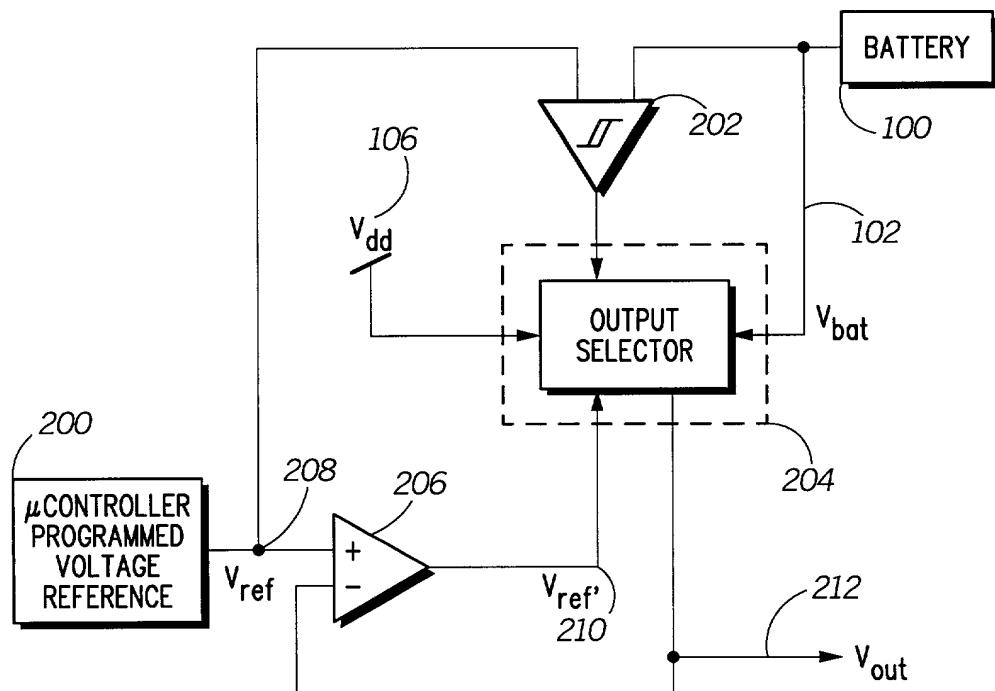


FIG. 2

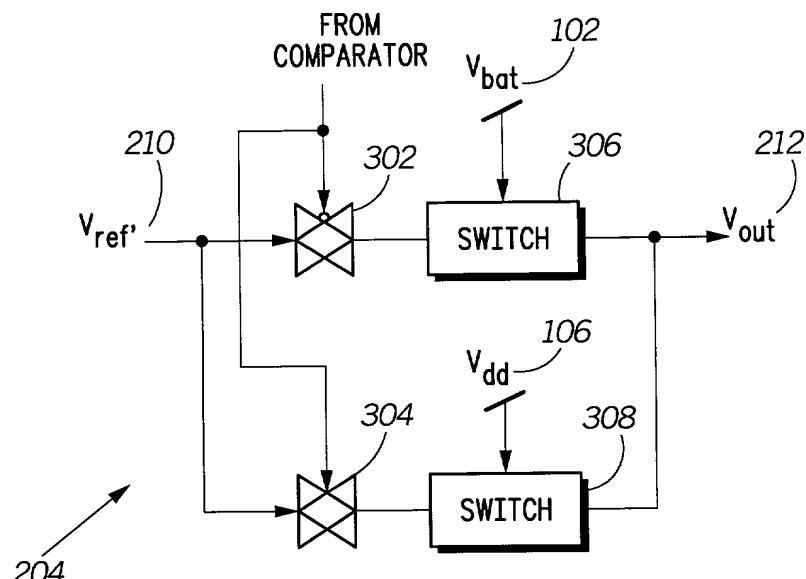


FIG. 3

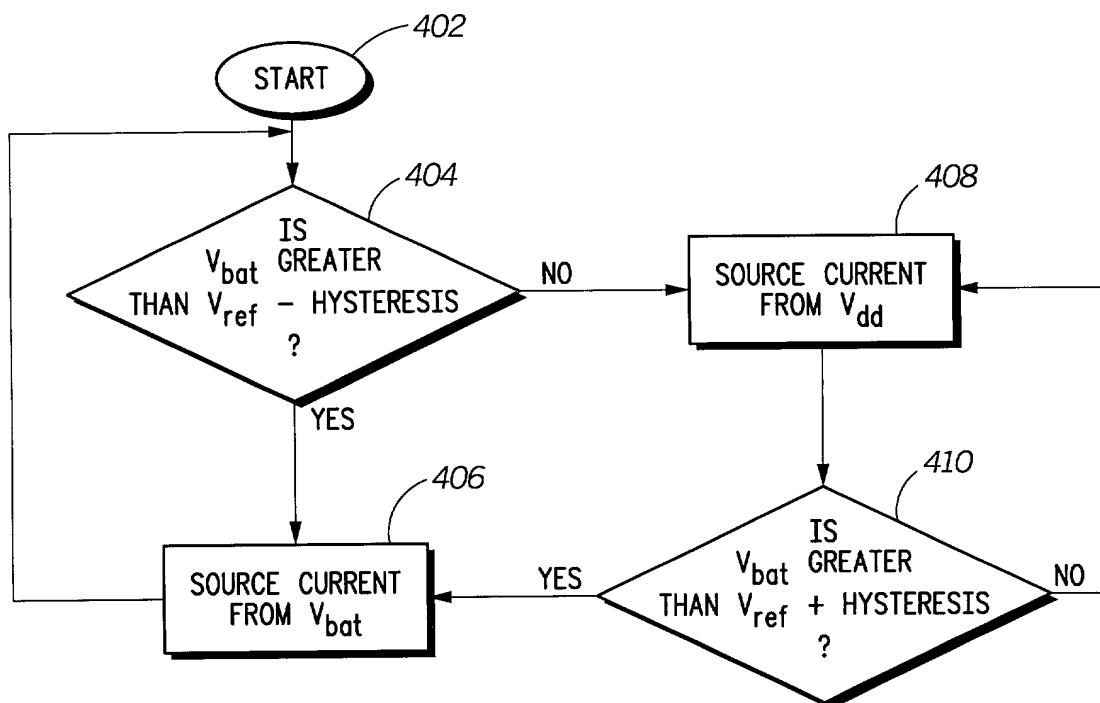
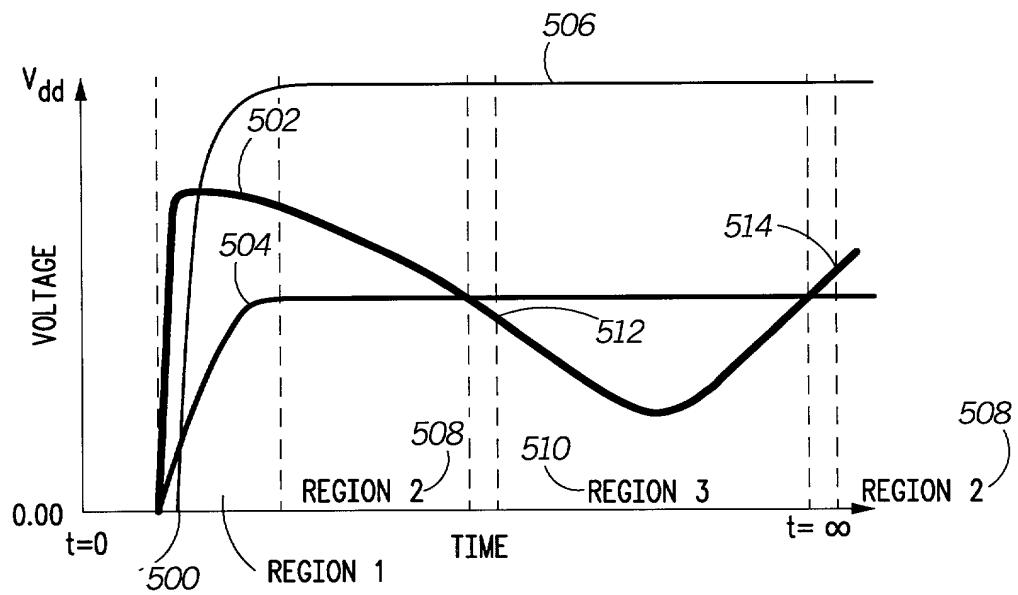


FIG. 4



***FIG. 5***

**PATENT APPLICATION DECLARATION  
COMBINED WITH POWER OF ATTORNEY**

Attorney's Docket No.: PT03130U



Regular (Utility)



Design Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**DUAL MODE POWER MANAGEMENT SYSTEM**

the specification of which:



is attached hereto



was filed on: \_\_\_\_\_

as U.S. Serial No.: \_\_\_\_\_

and was amended on \_\_\_\_\_

*(if applicable)*

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign/PCT Application(s):



no such application(s) filed



such application(s) identified as follows:

Application Number	Country	Date of Filing (day, month, year)	Priority Claimed Under 37 U.S.C. 119
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No

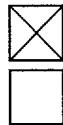
I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below:

Provisional Application Serial No.:

Provisional Application Filing Date: \_\_\_\_\_

I hereby claim the priority benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which is material to the patentability of this application and which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U.S. Application(s):



no such application(s) filed



such application(s) identified as follows:

Application No.	Filing Date (day, month, year)	Status (Patented, Pending, Abandoned)

I HEREBY APPOINT THE FOLLOWING ATTORNEY(S) OR AGENT(S) ASSOCIATED WITH  
**CUSTOMER NUMBER 22926** WITH FULL POWER OF SUBSTITUTION TO PROSECUTE THIS  
APPLICATION AND TRANSACT ALL BUSINESS IN THE PATENT AND TRADEMARK OFFICE  
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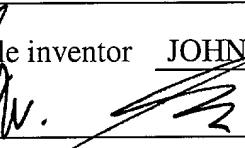
Send correspondence to:

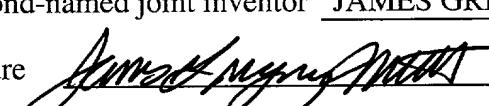
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Citizenship	<u>United States</u> Country	
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City	State or Country	Zip Code

Full name of second-named joint inventor <u>JAMES GREGORY MITTEL</u>		
Inventor's signature		Date <u>4/3/00</u>
Residence	<u>Lake Worth</u> City	Florida State or Foreign Country
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City	State or Country	Zip Code